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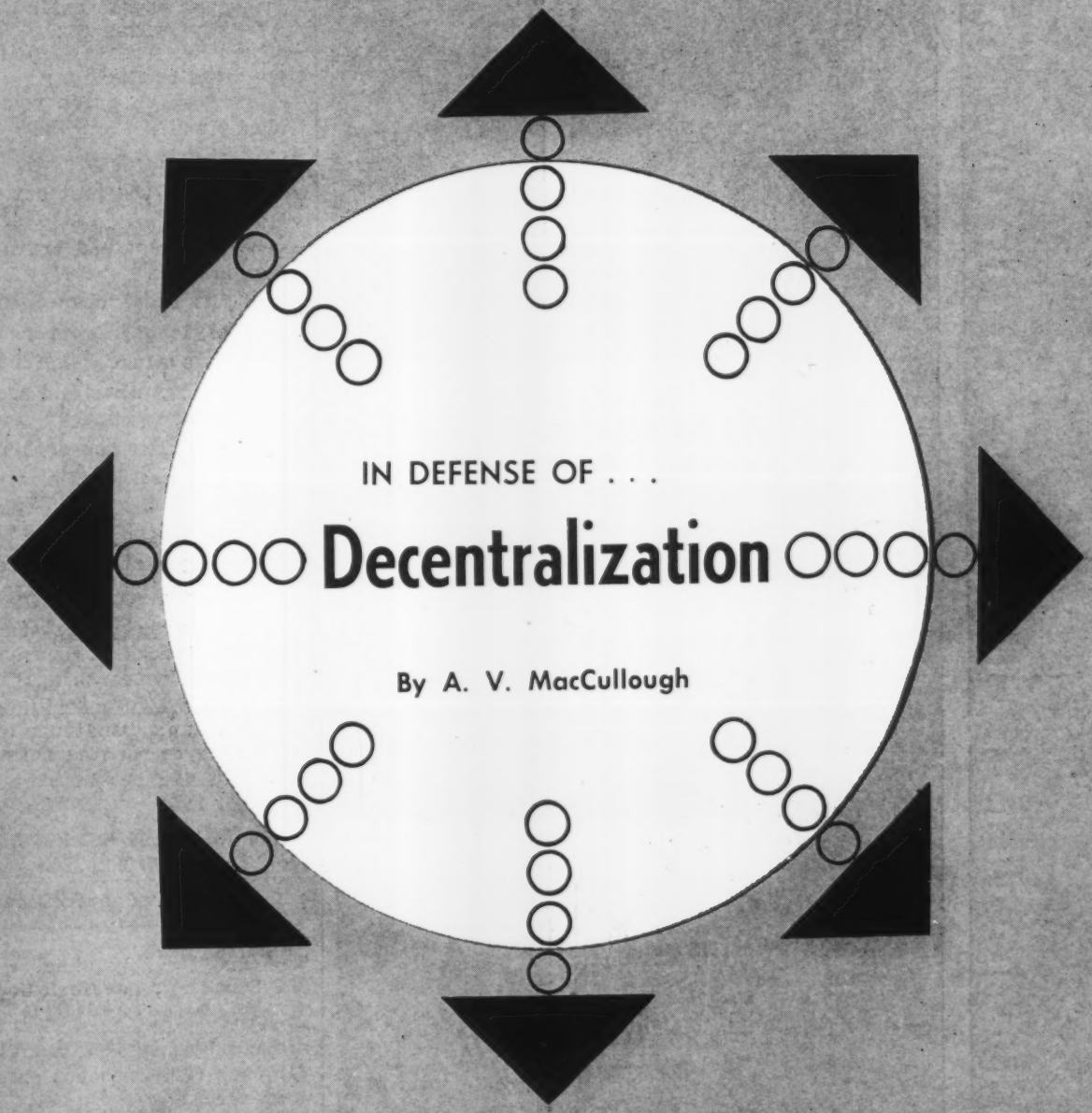

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Decentralization

By A. V. MacCullough

ALSO IN THIS ISSUE . . . THE SOCIETY: 1959-1960, BY D. L. BIBBY

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As a footnote to the review of the Society's activities during 1959-60, which appears on page 4 of this issue, we would like to thank Dr. Vincent A. Flynn, Editorial Consultant, and the members of the Editorial Advisory Board of ADVANCED MANAGEMENT for their distinguished direction, guidance and contributions in behalf of the Society's magazine during the past year.

—F. McN.

President's Report:

The Society: 1959-1960

By Dause L. Bibby

IT WAS A challenging year. It was a year, too, in which many new programs were advanced. Whatever success we have enjoyed has been due to the effort of many dedicated people who spent long hours helping to develop and promote the interests of our society. I would like to take this time to express some measure of gratitude to a representative group of those who have helped to carry on some of these successful activities during the year.

Long-Range Planning: Phil Carroll

First of all, I must acknowledge the sage and generous counsel and leadership of S. A. M.'s elder statesman, Phil Carroll.

As board chairman and head of the Long-Range Planning Committee, he has helped to steer us through rough waters. I hope he will continue to serve the society in the years ahead. His help is irreplaceable.

Executive Director: Walter Mitchell, Jr.

As to our senior staff executive, we have had a long and difficult period of search. However, as I have stated in previous reports, I believe the appointment of Walter Mitchell was one of the most important accomplishments of the year.

In the few months he has been on the job, Walter has covered much of the U. S., been to Puerto Rico, Mexico and Canada. This is further evidence of the international character and growth of S. A. M. In the national office many new procedures and activities have markedly improved our operations. I am certain S. A. M. will grow and be productive under his professional guidance.

Reorganization Plan: James Newsome

To the tireless efforts of Jim Newsome must go our appreciation for seeing a difficult task through to its suc-

cessful conclusion. It now appears that we have a workable and efficient organization plan to meet the changing demands of S. A. M. The Society should continue to progress under his presidency.

Advanced Management Course: Frank Bradshaw

Another major step taken during this year was a giant one toward moving the Society into the national management spotlight. Dr. Frank Bradshaw has assembled a wealth of material from a variety of institutions. This material has been collated and used in a management training pilot project in the Philadelphia area. This was made possible through the energetic and dedicated efforts of Carl Beck and the Philadelphia Chapter. The successful completion of these two courses has shown promise of expanding the project to its second stage. I have had the opportunity of sharing in this effort from its earliest formation at the Education Committee. It is my feeling that, if carried forward with careful planning, scientific safeguards and well-developed promotion, the course should create a new appreciation and awareness of S. A. M.'s value to American management in a critical and historic period.

Conference Programs: Pat Reddington

All of us have come to appreciate the loyal and dedicated efforts Pat has made on behalf of S. A. M. His contributions during the interim period between senior executive officers did much to make the work of the elected officers more effective. In the special area of conference management, Pat has helped to improve a situation that had been deteriorating. The excellent fall conference and the even more successful spring conference, one of our largest in recent years, are fitting testimonials to his and the staff's productive efforts.

Office Reorganization: Messrs. Hoag, Shore and Foley

Through the cooperative efforts of GE, IBM, and Remington Rand personnel, we were able to do a study of the national office. The recommendations of Messrs. Hoag, Shore, and Foley have helped to create more efficiency and savings to the office. Critical in effecting these changes and in implementing them has been our office manager, Marion Cusick, who together with the other women in the office, has worked often beyond the clock or call of duty to bring about a more efficient national office operation. I must express my personal appreciation to all of them.

University Division: Harold Fischer

I cannot imagine S. A. M. without the University Division or without Harold Fischer. His drive, his bountiful ideas, his productivity has created the real future of S. A. M. — tomorrow's business leaders integrated into the community of management leadership through S. A. M. It is only fitting that this year we were able to create the organization plan that took appropriate note of the growing importance of our junior chapters by designating the University group as a separate Division within S. A. M. with Harold Fischer, of course, its first president.

Finances: Robert Curry

Maintaining good fiscal controls and successful financial management is certainly one of the cornerstones of effective scientific management. Bob Curry has carried on one of the frequently unpleasant jobs in an organization in a manner that has upset no one, created friendships within the organization, prevented awkward situations from arising, and kept us in the black. Greater tribute hath no man for the keeper of the exchequer. His continuing leadership on the Executive Committee holds great promise for S.A.M.'s future.

Special Projects

To the director of research, Dr. John Mee of the University of Indiana, goes our appreciation for taking over a difficult job in developing some criteria for research planning and development. Our acknowledgment is extended to Dave Wise for his efficient handling of the senior chapter's activities and to Jake Sizelow and Lester Zerfoss for their guidance in the Execuitve Committee. Our gratitude goes to Hugo Druehl for his loyalty and effort on behalf of the Executive Committee and the membership campaign of S. A. M. He has been a valuable colleague and associate, as has our elected secretary, Maurice Bachlotte, to whom we also extend our thanks. Our appreciation is extended to Cliff James for his area conference, to Percy Eckholm for advancing the cause of small business activity, and to the Cleveland, Pittsburgh, Washington and Montreal Chapters for providing the gracious hospitality they afforded our Executive Committee meetings.

To the Unmentioned

There are some I may have inadvertently missed in paying tribute and thanking for their help during the year. But to those of you who have contributed greatly, if I may have failed to mention you by name, I hope you feel as I do, that one gathers strength and grows as an individual in being of service to others. I think your reward will be as rich as mine has been in having gained this experience as an officer of S. A. M. and as a member of the Executive Committee during 1959-60.

I cannot begin to thank those of you who have made the work of this year's elected officers lighter by lifting instead of pushing. I have received more in friendship and in better understanding of the responsibilities of S. A. M. than I could ever have contributed. For this I am appreciative and thankful to you all. ■

ADVANCED
Management
JULY • 1960

In Defense of Decentralization

By ALLISON V. MacCULLOUGH

Decentralization, says a noted management consultant, requires that we establish a system that operates against standards, objectives and goals, rather than against personal supervision

Mr. MacCullough is president of A. V. MacCullough Associates, a New York management consulting firm

IT IS APPARENT that significant segments of American industry are ready to indict the theory of decentralization as a fraud and ineffective as an organizational arrangement. While there is substantial evidence that some companies have had an unfortunate experience with decentralization, it does not constitute an automatic indictment of the theory.

It is quite needless to argue that all companies should attempt decentralization. In some cases there may be many substantial reasons why it is not feasible. And there will be but little disagreement that large companies which have installed accounting procedures involving the use of expensive electronic data-processing equipment should not decentralize such activities even though the organization is generally decentralized. Perhaps there are other functions such as purchasing or labor relations which should not be decentralized.

There remain, however, many companies which have attempted managerial decentralization and needlessly have had an unpleasant experience. It is the managements of these companies which are joining in a revolt against the theory and practice of decentralization who themselves, quite properly, can be charged with malfeasance. Why is this true? Where have they erred? In many cases such companies jumped onto the decentralization "bandwagon" without understanding the nature of decentralization and without first preparing managers at all levels, with an understanding of the concept, and of their respective roles and skills required in its implementation.

An illustration may help. Admittedly, this is an extreme case. A few years ago there was the president of a holding company with some twelve or fifteen subsidiaries on which he held a tight rein. This was strictly a centralized operation. Facing the prospect of three or more acquisitions in the near future, he became intrigued with the idea of decentralization. It sounded good to him because he had heard that under this theory he could enjoy much more freedom. Without discussing his intentions with even his closest associates, he announced at a meeting of the corporate officials and all his general managers, that as of that very moment the entire company was decentralized! He told each of the general managers to run his company in almost an autonomous manner.

Of course, in this instance, decentralization was a failure. In fact, it was decentralization in name only. As a result the president was forced to continue his personal direction of each of the companies and today he is quite vocal in his denunciation of decentralization. Let's examine this case to determine where he erred in omission and commission because it is somewhat typical of many situations.

Organization

First, the president failed to see that important changes in position requirements occur when the company is converted to a decentralized type of operation. Even though each general manager retained the same title, the same office, the same salary and the same reporting relationship, his position and responsibilities were substantially changed. If the president had tried to write the specifications of the re-constituted position of general manager he might have seen an amazing change and a radical difference between the specifications of the old and the new positions. And the same sort of alteration might have been required in many minor positions. A man might be a competent manager in

a centralized operation but a miserable failure in a decentralized operation because of these changed requirements.

Policy

It is certainly apparent that the president failed to see that decentralization means decentralization of decision-making to lower levels in the organization and all that that implies. He was expecting that the general managers would operate in accord with company policies with which he alone had been completely familiar. He provided them with no direct policy guidance with the result that frequently important questions of a repetitive nature continued to be sent top-side for his attention.

Delegation

This president also appeared to have no understanding of the nature of delegation. He did not know how to delegate, what to delegate nor when to delegate. Some of the general managers being cautious and conservative, were reluctant to make strategic decisions and continued to refer important problems to the president. They were not only lacking in courage but in the skills of decision-making. They, too, did not understand the nature of decentralization and their role in it. As a result, the president lost faith in them; yet, it was his fault, because he had never trained or tested them. To the extent that an individual avoids responsibility for any part of his position, it could be claimed that decentralization and delegation have not worked and that it is ineffective.

Other general managers tried to operate on their own. They thought that was what they were supposed to do and were fearfully reluctant to refer anything topside. In respect to these general managers, the president ultimately developed a fear that they in "going off on their own" were acting too independently and sometimes wrongly. He felt a strong desire to continually "look over the shoulder" of each man and at one time expressed the thought that perhaps he was running away from his presidential responsibilities. He failed to see that delegation does not mean abdication. In short, he did not like the way that either type of general manager was operating.

The "other side of the coin" revealed that the general managers were not happy with their new arrangements. They had not been provided with objectives, policy statements, performance standards for their divisions or any training for their revised responsibilities. They did not know how far they could or should "go on their own", for they were uninformed about the characteristics of their new positions or how much authority they had.

Controls

The fourth major deficiency in this situation was the lack of adequate management controls. This leads to the thought that the "reach of an executive" depends on the adequacy of controls. We have come to learn that we cannot decentralize without very much better control of objectives, very much better control of standards, and better control of performance than most centralized businesses have ever heard of. Decentralization requires a type of

DECENTRALIZATION

— will work if real authority is delegated

— will work only if adequate responsibility is freely accepted

— can be achieved when top executives understand that delegated authority cannot also be retained

— requires that business objectives, policies, organization structure and standards be known and comprehended by all

— requires confidence in subordinates

— places decision-making at the lowest possible level

— requires of headquarters people a sense of proportion, time and timing and the quality of patience

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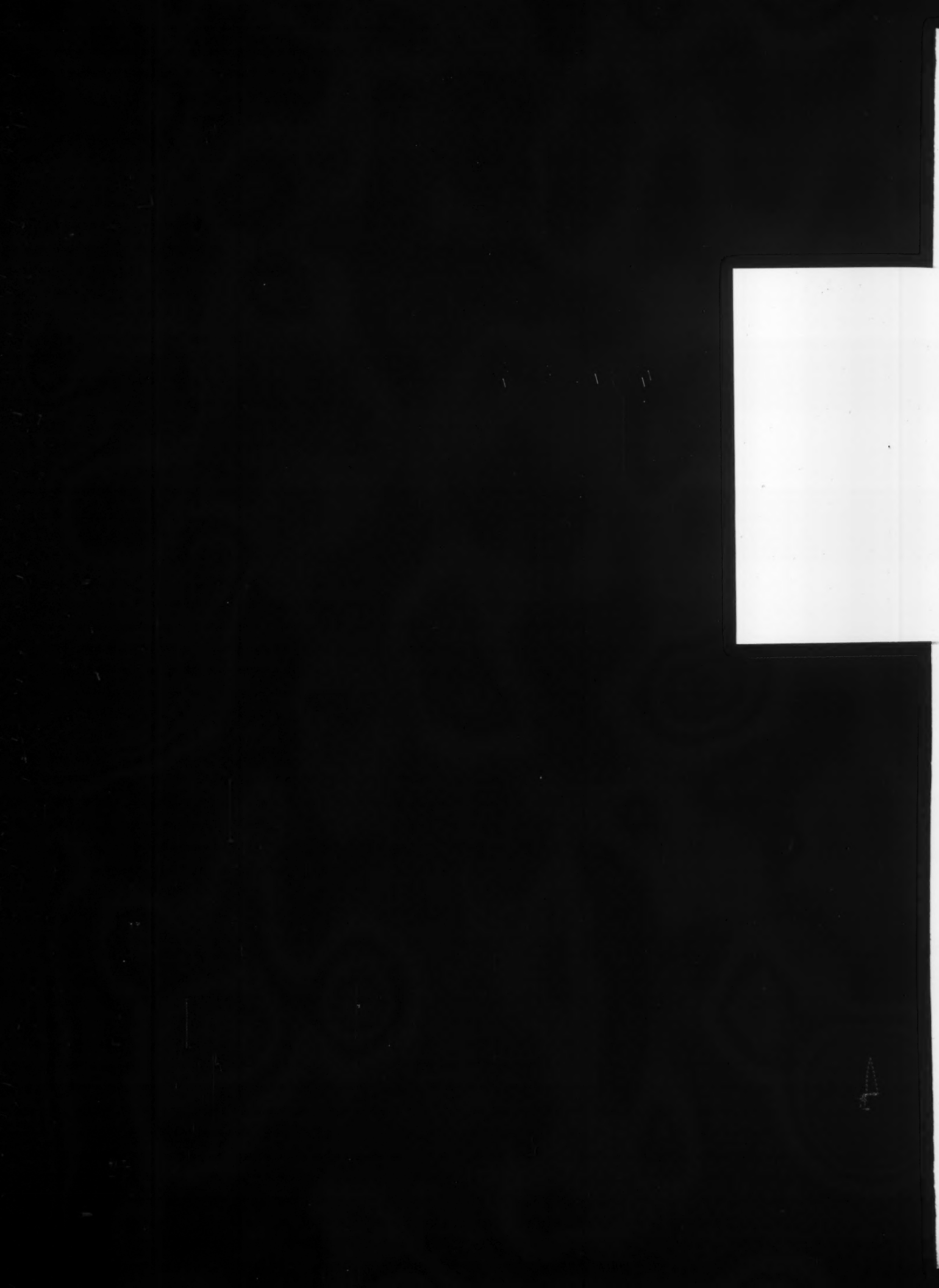


control frequently quite unlike those used in a centralized operation.

Decentralization requires that we establish a system that operates against standards, objectives and goals, rather than against personal supervision. Instead of thinking of controls as a useful management tool, this president subscribed to two rather unfortunate assumptions. He had not disabused himself of the notion that controlling is the exclusive job of the controller as many have traditionally and thoughtlessly believed. He was blind to the important concept that management controls are part of *every manager's* job and that financial controls are only one of several types.

Acceptance of Controls

The president was operating also under an additional handicap for he assumed that subordinates resent and resist controls. This is an assumption that has intimidated executives for a long time. This assumption has been held as the ultimate truth for so long that it usually goes unchallenged. Any boss, even with a minimum of persuasive powers, can present a sound concept of controls which will be welcomed by his associates. First, we must recognize that subordinates, being human, are selfish creatures. They will be appealed to by any process which serves their personal objectives. In respect to the job, what is it that these people want? They want to know where the business is going; what its objectives and goals may be. They want to know the plans for the company, their division or department so that they may detect when they are deviating from the plans. We must admit that that appeals to their self-interest. Then comes the matter of standards! Who doesn't want to know exactly what is expected of him? Good standards, objectively applied as a measure of a subordinate's performance are most likely to be accepted by the subordinate as fair, reasonable and as a challenge. Unlike the story of the lamp post and the drunk, good standards provide the subordinate with both light and support, as well as encouragement.

There is much evidence that subordinates value and appreciate controls because, when properly conceived and operated, controls enhance one's chances of success and recognition. Instead of being restrictive, autocratic or bureaucratic, proper controls provide freedom—they are not inhibitive—they encourage initiative at the lower levels of the organization where the real profits are made.

Perhaps the greatest advantage of "Management by Objectives" is that it makes it possible for a manager to control his own performance. He can detect deviations from a predetermined course. Self-control means stronger motivation; a desire to do his best, rather than just get by. It means higher performance goals and broader vision. Management by self-control underlies all the talk of pushing decisions down to the lowest possible level or of "paying people for results". To control his own performance, a manager needs to know more than just what his goals are. He must be able to measure his performance and results against the goals. These goals need not be rigidly quantitative or exact, but they must be understandable and rational.

Especially in a decentralized operation is there a tendency to think—and talk—about profit centers. Each unit or component of a business is often expected to "stand on its own feet" to make a substantial profit as a means of justifying its existence. This is but an extension of the simple thought that each employee must make a substantial contribution to company profitability. But, this type of thinking is more suited to the individual in the short range view than it is to a component of the business. Yet, we have those corporation officials who insist that immediately after decentralization, each segment of the enterprise must immediately show a profit. The luxury of long term planning is often denied the management of a component in a decentralized company.

Accounting "Straightjackets"

Judgment of the success of a division within a decentralized type of organization is often made on the basis of a twelve month cycle, as was the case in this particular company. Officials of an autonomous unit of a business are urged to think "BIG". They are invited to think policy-wise — in terms of strategic decisions and not only tactical decisions. Yet, at the same time, such officials find themselves under the unholy influence of a traditional accounting concept which has a time fixation of 12 months. There appears to be something sacred and inviolate about the 12-month period in the minds of many executives. Just why this is true is not readily apparent. The obvious excuses do not pardon the crime. Perhaps the answer should be left to business psychologists, the sociologist and the historian. But there never was a more devastating device that precludes long range planning than this hocus-pocus, mysterious and arbitrary establishment of the 12-month cycle as a period for measurement of achievement. Pity the poor general manager who must sacrifice long-range profitability on the altar of tradition for the sake of showing an immediate, though minor, profit before the year is up.

Even though ordinary horse-sense, and sometimes admonitions from headquarters, tells him to plan long-range, he does not dare to do so because he knows that his tenure in office depends on showing a profit within the confines of the sacrosanct 12-month period. It is often impossible to build a firm foundation for later and solid growth within such a short period; much time and money may be required to do so. Yet the personal security of the manager is related to his ability to show a profit in each 12-month period. It is as shortsighted as measuring a salesman's performance on a day to day basis.

An example of this type of situation may be helpful. In many instances all product research and development is a corporate responsibility and is financed at the corporate level. The results of its R & D are turned over to general managers to produce and sell. In many cases with a redesigned product, or with a new product, considerable market research is clearly indicated. While such research is not as costly as product research and development, nevertheless, it can easily amount to fifty thousand dollars or even ten times this amount. These funds, oftentimes, have to come out of the operating revenues of the division, and are not provided for out of corporate funds as was the financing of product R & D. This arrangement is often

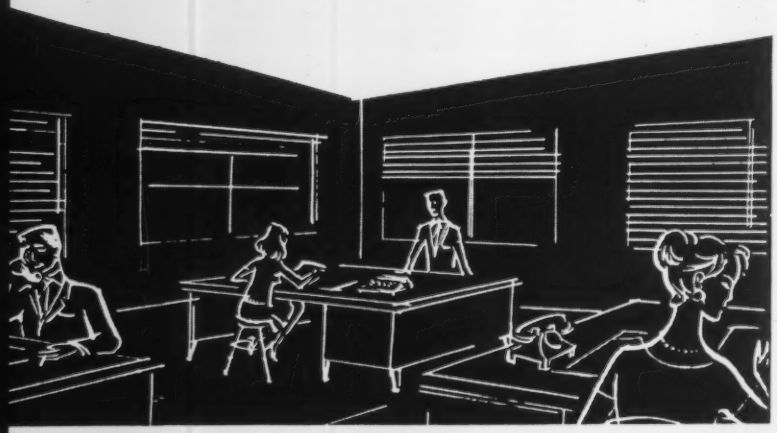
unfortunate for it sharply reduces the profitability of the decentralized divisional operation for the year in which the expenditure occurs. The general manager is apt to find himself in a dilemma. His good judgment clearly indicates the need for such market research and development, yet the compulsion to show a profit in each yearly accounting period is paramount, for the personal security of the general manager is often related to his ability to show a profit in each 12-month period.

Here is shown the fallacy of the thinking in many a decentralized operation that each unit of the business must make a substantial profit each year — the "profit-center" idea. The division or component in a decentralized operation that fails to show a satisfactory profit for a year or two, due to non-repetitive expenditures, for instance, for equipment or marketing research, is apt to be designated as the "weak sister" of the outfit. Failure to make a satisfactory profit sometimes, wrongfully, constitutes an indictment of decentralization.

The Role of Headquarters Staff

Another point of irritation—one that often itches terribly —is that of the role of the headquarters staff. There are many companies under centralized management which have a headquarters staff composed of such line positions as chief engineer, chief chemist, chief accountant or controller, directors of labor relations, purchasing or manufacturing. In most cases these men have real authority in their respective areas in the numerous plants of the company. When decentralization occurs, the revised roles of these headquarters people are frequently not re-defined to anyone's satisfaction. Are they "line" or "staff"? Have they the right to order or to advise? And, if their advice is not accepted, what are the consequences? Here is the perfect set-up for a mud-slinging contest and the basis of political internecine warfare within the company.

In such cases the newly decentralized company professes to offer complete independence to the several units of the business. However, there often seems to be great difficulty in cutting the corporate "umbilical cord". It reminds one of the untenable situation when a newly married couple living close by the parents may rarely make decisions on their own or live their own lives because of the over-powering paternalism or concern of the "old folks". The wise parent, or in this case, the parent company must show an admirable degree of restraint. The desirable attitude of the parent company is not easy to define. Certainly it must look for long range results. Like the wise parents, it must be prepared to offer advice when solicited and also to help finance a venture when the prospects of paying off—grandchildren or otherwise—may be indicated.



Corporate senility becomes evident in a situation of this type for there often appears a lack of courage or intelligence adequate to resolve the difficulties. Again, we have the presumed basis of an indictment of decentralization.

In other cases decentralization has appeared to fail when the president is domineering and dogmatic. Sometimes the founder of a business, anticipating his own retirement and realizing that he has no heirs able and interested in taking over the business, is appealed to by the thought that managerial decentralization may solve his problem. In his failure to have an heir or a counterpart of himself, he has neglected to develop a qualified successor—someone capable of running the entire enterprise, he hits on the notion that perhaps "smaller" men may successfully run segments of the business.

Even when capable men have been under the strong and continuing domination of an autocrat for years, it is unlikely that they will be very effective when placed "on their own". They are apt to miss the strong leadership and the unifying force provided by the president. Their natural desire to succeed may result in a ruinous political struggle and what was once an integrated organization team becomes a loosely knit series of alliances.

Criticisms of decentralization have also come from companies that have purchased other businesses. The former management is retained and even though it is provided with general statements of policy and direction, it is too much to expect that the new acquisition is going to act like a member of the "family" immediately or without considerable indoctrination. The loss of corporate identity often has a disquieting effect on the officials of the new acquisition. Even though they may have a strong desire to do exactly what is wanted and in an approved manner, it often requires considerable time to re-adjust to the new relationships.

This could be compared to the adoption by a family of a couple of teenagers. The desire of the family to welcome them into the home is sincere and as great as that of the youngsters to cooperate and fit into the mores of the family. Yet it is inevitable that both sides must be tolerant and indulge in considerable "give and take" before the completely harmonious working relationship is developed.

It could be claimed that "decentralization" is an attitude; a state of mind; a philosophy. Perhaps that is correct. But, it is more than that. Like the parent of a teenager, the company that has not prepared its progeny for independence, should never attempt decentralization, any more than the parent would encourage the child to undertake the responsibilities of marriage until it has learned how to live on its own.

In the nature of a summary, we have the situation of a parent company which is pushing the children out of the nest before they have learned to fly. And, that is an indictment of the parent company and not of decentralization! ■

The Management Training Laboratory

—*A Way to Improve Organizational Effectiveness*

By BERNARD M. BASS

MORALE means many things to many people. For some, morale has meant the attraction of a man to his group; how much he expected to be satisfied by membership; how much he wanted to be a member of his group. For others, morale has meant effectiveness, the extent the group was actually rewarding, the experience of satisfaction with being in the group. For still others, morale has meant both expectation of being satisfied as well as truly being satisfied. However, the dynamics involved in attractiveness, the expectation of satisfaction; and effectiveness, the resulting satisfaction, are quite different and it becomes of some importance to separate the two when we wish to examine the problem of morale in its entirety.[1]

What are some of the factors which increase our feelings of expectation that we are going to be satisfied in a group? What attracts us to a group? What keeps us in a group? What makes it hardest to get us out of a group? First, it depends on the group's goals. If what I want is in line with what is wanted by the rest of the group; if the group and I share the same goals, then I am more likely to be attracted to that group. If the group is working primarily to increase the prestige of all its members, and I am not particularly interested in gaining more prestige than I now have, I will not be particularly interested in remaining a member of that group. If the group centers on being productive, and I am interested in such productivity, I will be more satisfied to remain in such a group. I will also be more attracted to a group if its goals are clear to me and I can evaluate that I share the same goals as the group does. Whether or not I am attracted to the group will also depend on such matters as whether the group in the past has been able to obtain its goals; whether it has been successful in the past. If the lion's share of the rewards tends to go to one or two members of the group, I may be more reluctant to remain in the group than if there is a more equitable distribution of the rewards for membership.[2]

In the same way, the dynamics of group effectiveness, whether or not the groups are actually satisfying, depend on many different factors. Some people are satisfied mainly because of the challenge and interest they find in the job they have within the group. Still other persons concentrate obtaining their satisfactions primarily from the arbitrary material benefits or the opportunities for advancement or promotion associated with the particular job they have in the group or organization. Still others are primarily satisfied with the organization and its overall activities while still others find their satisfactions and dissatisfactions coming mainly from the relations they establish with their peers and superiors in the group.

Interaction Potential

How do we raise the effectiveness of a group? If we can raise a group's effectiveness, we are likely also to raise its subsequent attractiveness to members. The answer to the question lies partly in increasing the *interaction potential*

[1] Bass, B. M. Leadership, psychology, and organizational behavior. New York: Harper & Bros., 1960, p. 43.
[2] *ibid.*, p. 63.

Dr. Bass is Professor of Psychology at Louisiana State University, Baton Rouge, La.

within a group.[3] Interaction potential is likely to be lacking in large groups, groups spread out geographically, groups with poor communications, groups that are unattractive, groups whose members are unfamiliar with each other, groups where members have little confidence in each other, groups in which there is little intimacy, and groups in which the interpersonal relations are quite immature. On the other hand, interaction potential will be greater in smaller groups, groups closer together physically, groups with speedy and accurate intercommunications, attractive groups, groups of high mutual esteem and where members are familiar with each other and in which interpersonal relations are mature.

The lack of interaction potential in a group results in an inability of individual members to predict each others' behavior. The centuries-old solution for increasing predictability in a group has been to formally organize the group. This is the way to get large numbers of men to work cooperatively on complex tasks. In formally organizing we follow certain key principles: each person in the group has a clear job assignment; each job is stated so that other people can predict what the job holder is likely to do; there is no overlapping of effort; there are clear channels of authority, etc.

Problems of the Formal Organization

Formal organization brings with it many new problems. In any formal organization, some jobs are more important than others; have more value. The company president, for example, is more important to the success of the firm than the janitor. And along with this higher status that the company president receives goes greater satisfaction. Along with low status goes dissatisfaction. Unfortunately, in any given company there are many more janitors than presidents. Thus, we automatically build into the formal organization a lot of people with relatively dissatisfying positions and few people with highly satisfying positions. Resentment, hostility and status struggle are likely in the formal organization. A second problem we find in the formal organization is the tendency for the people of high status, the presidents, the vice-presidents, the managers and the assistant managers, to have goals which are quite different from the goals of those of the rank-and-file. As the number of echelons grow with the growth of the organization, the goals of top and middle management are likely to grow further and further apart from those of the workers and men in lower management positions.

Still another problem that is usually cited when we look at governmental agencies (although it applies to any formal organization) as they enlarge themselves is the long job tenure of the office holders. The typical bureaucrat becomes less and less concerned about the job to be done and more and more concerned about himself.

Still another problem of the large organization or the old organization is its intolerance for criticism and opposition within-the organization; for opposition becomes disloyalty. In the monolithic society and in the monolithic formal organization, to be against those in high office is to be disloyal. There can be no loyal opposition.

Another negative feature of the large many-layered organization is the appearance of a filter system, due to the problem of communications having to pass through many echelons as they go up and down the chain of command. As communications pass upward we find they are consistently shifting in content and direction as desired by those who are transmitting the information.

Still another problem which presents itself to a formal organization is that of rigidity in the face of new problems which it was not originally created to handle. Often, old organizations are likely to be inflexible and not geared to cope with new problems.[4]

How can we supplement the formal organization as a means of increasing interaction potential and reduce some of the negative features of the formal organization which inhibit the very interaction potential which the formal organization was set up to foster? The answer lies in a variety of techniques. Some of these are training programs or educational programs which will increase communicability in the organization, increase mutual confidence in the members of the organization for each other, and increase the maturity of personal relationships which exist within the organization. How do we do this? I think one of the approaches is the management training laboratory.

The Management Training Laboratory

The management training laboratory is a procedure for getting members of management to relate better to each other and to their employees. Paradoxically, it succeeds

[3] *ibid.*, p. 372.

[4] *ibid.*, p. 416.

in doing this by taking the management group away from its organization, stripping away the organization from the training group and essentially forcing the members of management to get together without any organization at all. This results in the individual member fumbling and stumbling when he tries to come to grips with the problem of developing a set of procedures for interacting with the other laboratory members in his group. Previously dependent on the organizational rules as the source of information for many of the decisions on how to interact with other members of management, now the trainee must rely on himself and his fellow trainees for the answers.

What is this new training method actually like? It is a laboratory. By a laboratory, I mean it has certain characteristics similar to a physics or chemistry or psychology laboratory. It is a laboratory in a sense that the individual learns primarily by observing himself and his own behavior and that of other trainees as the trainees develop the means of interacting with each other. A basic feature of this training is the development group or the training group. From 8 to 15 trainees are brought together for about 15 to 20 two-hour sessions during the training period of one to two weeks. Their assignment is to figure out what they are going to do with themselves during the two-week period, what kind of an agenda they will work with, what they will talk about, what procedures they will use to make decisions, and how they will interact with each other. There is a trainer with the group, but his role is simply that of a staff member who will help the group when and if they want his help. He is neither the chairman nor the leader of the group; in fact, groups quite often never elect a chairman or leader as such.

Since in our society, most adult men are highly task-oriented, particularly members of industrial management, there is a tremendous desire to select and complete satisfactorily some one or several tasks. However it begins to become apparent that the central issue facing the group is that of becoming a good group. There is an increasing concern about the interaction process by which the members hope to work together on their mutually selected tasks.

The Good Group

What do we mean by a good group? We mean a group that is likely to be high in interaction potential for the situation and circumstances presented to it. Therefore, a good group is likely to be an effective group since increasing interaction potential is likely to promote group effectiveness — the extent the group rewards its members.[5] It should be pointed out that the staff begins operations deliberately reducing interaction potential and deliberately making the assembled collection of individuals as ineffective as possible. For example, typically 12 or more men are put together to accomplish a set of tasks, which could probably much better be handled in terms of discussion efficiency by six men. Again, the situation is without structure, making it difficult initially for people to predict each other's behavior; thereby reducing interaction potential. It is these very obstacles of group size and structurelessness which must be overcome that provide the opportunities for learning how to become a good group through a variety of other kinds of changes. And in learning what these other possibilities are in this training group, we see how we can return to the industrial setting with some feeling for how to improve our formally organized work groups. The trainees do not gain these new attitudes and ideas through lectures or demonstrations, but by observing in themselves and others the need and the effect of trying out these new ways of behaving and operating as a group.

One characteristic of a good group is that the individuals' goals and the group's goals are integrated. Members learn that if the group is not responsive to the individual needs of the members, if the group's goals are not shared by the members, if only a few of the members needs are being satisfied by the current group activities, the group is not going to be successful, participation will be half-hearted and there will be a minimum of satisfaction to all members.

A second attribute that is learned that makes for an effective group is that each member can take appropriate roles whenever they are needed. No one has to be told to do something that will contribute to the group's effectiveness. When he sees the need for some particular function to be carried out, each and every person is capable and willing to carry out that function or play the needed role. When the function or role are not needed, he does not attempt to carry out the function or play the role.

Giving support relates to a third aspect of effective group activity, namely appropriate communications of feeling and thought. Somebody says something to you that is disturbing to you. Instead of burying it and carrying the consequential resentment around with you for the next few weeks, you openly discuss the question and try to point out what in the statement to you made you feel disturbed. Conversely, if someone says something that makes you feel good, again you tell him that it was satisfying to you, thereby giving him support for what you regard as a favorable comment.

A fourth characteristic of a good group is its tendency to permit a wide variety of behavior, to tolerate deviancy. The member who disagrees with the rest of the group is not excommunicated from the group for his disagreeing. It is possible to remain in loyal opposition to the group rather than be criticized as disloyal for opposing the group majority. If differences cannot be resolved, then at least there is a possibility of trying to establish where the differences lie so that members may remain deadlocked yet have

[5] *ibid.*, p. 45.

an unemotional unbiased conception of the amount, scope and direction of the differences.

Consider when 11 members of the group, feeling themselves a clear majority, wish to move in one direction; yet, the one deviant in the group wishes to move in a somewhat different direction. If the 11 members say that as a clear majority their viewpoint should prevail, the deviant develops extremely negative feelings about his group. He grows resentful and dissatisfied. If the deviant persists in his beliefs, the group is likely to reject the deviant eventually ejecting him psychologically from the group. On the other hand, groups tend to be more effective when the 12 men strive for consensus, a genuine acceptance by all 12 of a commonly constructed agreement rather than accept an 11 to 1, or 10 to 2 or 9 to 3 decision, or a decision pushed by a majority or half-heartedly accepted or secretly rejected by others. Why? When true consensus is achieved by a group on a decision, it is more likely that all the members of the group are ready to work to carry out the plans resulting from the decision. When even one member remains disgruntled, in disagreement, either openly or secretly rejecting the decision which has been forced by the majority without his consent and acceptance, he is likely to remain a sore in the body politic. When the group works to achieve consensus, even where there is one strong holdout blocking this because of his deviant position, it is interesting to see that when consensus is finally achieved, the deviant does not feel that his opinion was ignored or rejected by the group or that he gave up his own beliefs and opinions. Rather he is likely to feel that the rest of the group moved over to his way of thinking, which they probably have not really done. Indeed, the final decision reached by the majority and through consensus may not be very different. But the way the minority or deviant members feel after the group has strived for consensus in comparison to where a majority decision has been rammed through makes for a big difference in the effectiveness with which the group can proceed to carry out the decision.

In contrast to consentual decision-making is this fifth attribute of a good group. In its early stages of development, the training group usually sees decisions being made by individual members. Each member authorizes himself to do almost anything he pleases without much regard for the feelings of others in the group. One member may say, "I think we might do well to take an hour to discuss our housekeeping problems. . . . "This member now proceeds to discuss the issue for the next 10 minutes without having anyone else really interested in what he is saying. Another common method of decision-making at this immature level in the group's development is *hand-clasping*. One member indicates his interest in discussing bird watching. A second member says "Jim, that's a good idea, go ahead." And the two proceed to continue this discussion, taking up the group's time for the next half hour before they realize that no one else in the group is particularly interested in bird watching. At this level in a group's growth we observe two members or a minority of members seemingly making decisions for the entire group. These decisions tend to be accepted half-heartedly or not at all resulting in a frustration and failure to complete or carry out what was decided upon. At a somewhat later level in the group's development, majority opinion prevails with the consequent embittered minority.

It is one thing to say that the democratic process calls for the minority of members to go along with the majority. It is another thing to make the minority feel good about it. It is this feeling of satisfaction with the decision which is aimed for in our striving to achieve consensus rather than relying on majority voting to decide the group's questions.

A sixth characteristic of a more mature group is its flexibility of organization. Where different problems arise, it is able to regroup, reorganize and cope with those problems as they occur in whatever way necessary. Associated with this flexibility is the tendency of members to each rise to play appropriate roles as needed in the manner described before.

Also associated with this flexibility is a seventh attribute of effectiveness, the tendency to make appropriate use of their available resources. For example, if the topic for discussion is automation a company has introduced and there happens to be a systems engineer in the group, his advice is solicited and warmly welcomed, not because he is the only expert in the group on this subject, but because what he can provide as expert is sought openly and willingly. Yet, the other members do not necessarily accept what the engineer has to say simply because he is an expert. Status differences of this sort are not allowed to interfere with good judgment and weighing the facts as presented in an unbiased manner. Economics, resistance to change, seniority problems may all be involved concerning the issue. When the group has reached a high level of maturity and the preceding characteristics of a good group are evident it can be seen that the group is able to work together much more creatively. Members build on each other's contributions. What one member says is taken up by another and elaborated, modified, improved, examined in more detail in successfully higher levels of discussion. This in contrast to the "bull sessions" of an earlier immature phase where

THE TRAINERS

The National Training Laboratories, which initiated this approach to management development, has been in operation for over a decade. Although it first concentrated on community organization problems, it is now more actively engaged in training industrial management running special laboratories for industrial executives at Arden House, Harriman, New York. One week laboratories are also held jointly sponsored with the Society for Advancement of Management.

Many individual companies now have adopted such programs including Esso Standard Oil, Republic Aviation, Beltone Hearing Aid, Ansul Chemical, American Telephone

one topic follows another with little growth or creative integration of ideas.

Related Issues

During the process of becoming a more effective development group a number of topical issues are uncovered if the development group is composed of a diagonal slice of an organization — representative members from different levels in the "back home" organization from different operating units of the organization. No member is the immediate superior of any other member in the training group, but all members come from different echelons.

The effects of status on power are brought into sharp focus in such groups and the fact that the status-power problem is a two way affair is seen. First, the members on top in the "back home" organization find that they are much more influential in the training group than they have tried to be. It becomes apparent through feedback that even a mere shrug of the shoulders or silence itself is an important source of influence if it comes from a high status or a person with a great deal of status in the group. He has influence because of his potential to reward or punish others around him "back home". Often high status people do not realize the effects of their jokes, their sarcasms, their indifference, their modes of questioning others and much of this comes out when the persons of low status open up and reveal their feelings to the high status people. Persons of high status learn that they have been blocking communication although they did not intend to do so.

Similarly, persons of lower status, lower in the echelons "back home" learn that those on top of the organization are simple human beings too, that they are approachable and they can be talked to. Moreover they see that the top people are interested in obtaining the correct information, do want to be helped by those of lower status and do not wish simply to be told things that persons lower in the hierarchy judge the top people want to hear.

The impact of the silent member on the group is a problem which members become much more aware of. Often silent individuals learn that they are heartily disliked by the group. Why? Because the silent member may be a threat to the rest of the group. Nobody knows what the silent member's decision is on hardly anything. He is disturbing; particularly if after the group has been proceeding in one direction the past half-hour, the silent one drops a hint that he is not really particularly interested in what's going on or if he makes other members feel that they are performing as puppets in front of him. Actually, the silent member's behavior may be due to the fact that he is fairly shy but he doesn't realize what his shyness has done.

Still another matter learned is that people may not be saying what they mean and what is actually going on in the group may be due to an agenda which is not an open one known to all but an agenda based on some concealed desires which persons or persons having these desires may not even be clear about themselves. Such hidden agenda are likely to be detected after awhile by other members of the group. Bringing these hidden agenda out into the open may be helpful both to persons having these hidden feelings as well as to the group as a whole for its progress. However, such groups normally will find it not too profitable to become group therapy sessions in which attempts are made to probe into the past experiences of the individual members and their immediate motivations in trying to understand the whys and wherefores for the existence of these hidden agendas. Rather the group accepts the existence of these feelings for what they are and attempts to cope with them as best they can. A group therapy session would devote most of its time to working on the reasons for the individual differences in motivation and feeling of the members of the group. But the development group concerns itself primarily with these as given aspects of a normal group requiring attention and to further the group's process toward becoming a more mature group.

The Future of Laboratory Training

As industry continues to become more technical in aspect, the problems of communication and organization increase in intensity. Many of these problems involve an interaction of human and technical matters which are so intertwined it becomes impossible to divorce one of the other. For example, we say that intelligent decision making by top management requires rapid feedback of the effects of earlier decisions, but this rapid feedback requires the skills of accountants and planning engineers as well as the cooperation of production supervisors on the line. Management must have the technical know-how to interpret the reports, accountants must have the facility to design the reports, production executives must have the ability and motivation to complete the reports quickly and accurately. It is not difficult to see that with this kind of technical-human problem which is characteristic of modern American industry, a management training program will be a profitable one which focuses on getting members of management to relate better to each, to improve in their ability to predict each other's behavior, to become more aware of each other's feelings and concerns and to work together more cooperatively and creatively. ■

& Telegraph and Champion Paper.[6] In addition such organizations as the YMCA, The American Red Cross, the American Cancer Society, The National Democratic Party Organization and the Episcopal Church have turned to this kind of program for training their leadership. Sensitivity training laboratories are run annually by UCLA, the University of Texas, the University of Utah and the University of Michigan.

[6] Ferguson, C. K. Management development in "unstructured" groups. *California Management Review*, 1959, *1*, 66-72.

Hoy, G. A., Jr. A brand-new breakthrough in management development. *Factory*, 1959, 74-79.

ONE NEED ONLY read current publications each month to be awed by the remarkable advances in science and technology, and in their application to human problems and needs. A theoretical plot of advances in science and technology over the past 100 years would show a sharply ascending curve. A similar plot of advances in human relations would, perhaps, show a line almost horizontal, or, at least, with very little upward trend.

If this be true, can lack of progress in human relations hinder, or perhaps nullify, the full corporate benefits to be derived from scientific and technological improvements? In order to try and answer this question, let us look at a few actual examples, and then consider what can be done to improve the situation.

First, take a favorable example from the field of science. A few years ago, the United Nations sponsored a conference of scientists in Geneva, Switzerland, concerned with an exchange of information on scientific advances in the field of atomic energy. The director of this conference reported that the value of Russian participation was threatened by the wall of suspicion (perhaps with justification) that existed between countries of the West and Russia. This was so real that there was fear that a visit to Moscow by those with know-how in the field might be hazardous. What to do? The director decided on a trip to Moscow (without the unqualified blessing of our State Department) for the purpose of meeting with Russian scientists and supplying them with copies of papers that were to be presented by the Western Powers. What was the result? After witnessing a demonstration that "all the cards were to be on the table" with no reservations, the Russian scientists responded in like manner, contributed a young scientist to be a deputy director — who performed most creditably — and helped to make the conference a success. A conference director who had been unwilling to "give a little" probably would have been unsuccessful in obtaining cooperation. How many international conferences have failed because of stubbornness of individuals or lack of friendly relations?

We hear a lot about executive development and motivation in business from company officials, schools of business administration, and management associations. The requirements of a program for developing executives are frequently stated as follows:

1) Know-how, or knowledge how to run a business and make money.

2) Skill in leadership.

3) Knowledge of the business.

In the larger companies, there are few top executives that have not been exposed to the principles of good management, and this is also true in a significant number of smaller ones. Similarly, most men, women and children know the content of the biblical ten commandments. Whether one is talking about the biblical ten commandments or about the Ten Commandments of Good Organization published by the American Management Association, the number of people who try to observe the rules by regularly practicing what they preach — if they preach at all — are in the distinct minority. We, therefore, ask the question; have there been significant advances in the field of human relations over the years and if not, isn't it equally

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important to concentrate on improving the personal character of potential leaders, as it is to try and educate these same people in methods and procedures? Let's look at a few illustrations from the business field.

CASE 1. The company was originally family owned. The second generation did not measure up to its predecessors, and the company found itself in the hands of a president:

1) Who broke practically all of the Ten Commandments of Good Organization with startling regularity.

2) Who was erratic and vacillating in decisions.

3) Who surrounded himself with "court favorites" who were ideal "yes-men".

Result: Continued business crises, critical reports by outside consultants — with suggested changes which were not adopted — and maintenance in office of incompetent and disagreeable officials. Finally, the company was sold to a larger organization and completely reorganized. During the above president's term of office, executive development and motivation was practically non-existent.

CASE 2. A most successful nationally-known company acquired a "personality-plus" president who, through a series of clever maneuvers, had won for himself the top executive post. He also controlled the board of directors. The president's egotism and desire for personal glory reduced the function of the directors to that of "rubber stamps". When profits turned to losses, a ruthless hatchet-swinging campaign was undertaken which practically ruined company morale without improving profits permanently, and caused untold hardship to many executives of long service.

(*Continued*)

Advances in Science and Technology

By W. I. McNEILL

A private management consultant, Mr. McNeill currently serves as chairman of the Business Improvement Service of the Greater Hartford (Conn.) Chamber of Commerce

Here again, executive development and motivation took a vacation for a period of up to ten years.

CASE 3. This is a case in which executive development and motivation never existed and probably never will under present ownership. The company is family owned and dominated by the man who built it up to a successful money-making concern. The owner, who is president, treats his executives like children who continually need a spanking. In addition, he follows the practice of enticing competent executives at better than average salaries, getting all he can out of them for two or three years, and then making their life so miserable that they either resign or get fired.

CASE 4. A president whose ego had been exalted by his position, he seldom listened to the suggestions of his official family, and when things went wrong with his decisions, he tried to pin the blame on one of his subordinates.

CASE 5. A set of officers in a family company, all between the ages of 65 and 75. Modern ideas and suggestions from younger subordinates fell on stony ground because the top men were living in the past. Result: loss of good men who got tired waiting for a change.

CASE 6. A company executive who was jealous of his subordinates' abilities, thinking that they would receive more glory than he would.

In the field of industry since the industrial revolution, history shows that the transition from child labor at almost double the present hourly work day and intolerable working conditions, to the present hourly work day with reasonably good working conditions and fringe benefits, was not brought about by big-heartedness of individuals, but was largely the result of some crisis or catastrophe which aroused public opinion to the support of trade union demands or for needed legislation. It is interesting to read a college text book on Socialism of the early 1900's — which was considered slightly "pink" at the time — and compare the suggested benefits with those of the present day which are accepted as commonplace. As someone has said: the liberal of yesterday is likely to be the conservative of today.

The files of management consultants are full of cases similar to those given above, and it is such things that keep the management consulting business good, both in correcting bad practices and in recruiting men for replacements in top level posts. Furthermore, this article would fill a book if one tried to give similar illustrations from the fields of either union or management relations — both internal and external—or from the fields of town, city, state or national government, or from politics in some educational institutions. One might even glean a few examples from religious or charitable institutions.

On the optimistic side, one could, without question, give many illustrations in which leaders were an inspiration to those coming in their sphere of influence, principally because they were men of character, who knew the rules of organization, who were successful in administration, and practiced what they preached. Such illustrations would, I fear, be a small percentage of the whole.

Whereas there have been phenomenal advances in science and technology in the past 100 years, there is little evidence that there is less greed, avarice, suspicion, jealousy, dishonesty, egotism, coldness toward others, and other negative human characteristics than there has been since the dawn of civilization. Customs and patterns of living have changed remarkably, but human relations very little. The percentage of good people to bad probably remains about the same.

"History shows that the transition from child labor and intolerable working conditions to the present hourly work day with reasonably good working conditions and fringe benefits, was not brought about by big-heartedness of individuals, but was largely the result of some crisis or catastrophe which aroused public opinion to trade union demands for needed legislation." At right, the Haymarket Riot of 1886.

Therefore, if we admit that the lack of progress in human relations is a retarding factor in utilizing to the fullest extent advances in science and technology, we must recognize the need for choosing leaders in all fields — industry, education, politics, the professions, etc., — with primary emphasis on the fundamentals of character. We will, admittedly, never develop "angels", but at least it is believed that the situation can be improved.

Since human relations appear to play so important a part in the success of any undertaking, be it in the field of education, business, politics, or what not, is it not important that more thought be given to choosing leaders who will set a good example for the entire organization? It it not a good bet that leaders of the right kind can make the organization more successful and profitable in the long run?

How are leaders chosen at the present time in a majority of cases? In the field of politics, it is often the person who is a fast talker, has the most glamor, or who has the backing of the ruling clique, which may not always have the best interests of the public at heart. In industry, first consideration may be to one of the following:

1) A friend of the largest stockholder.

Culver

2) A successful lawyer, salesman, or manufacturing executive with emphasis on ability to get things done.

3) A relative of the official family.

In educational circles, the choice of a leader may be the ability to raise money, although in education, as in religion, there is more of a chance that the incumbent will be chosen for real ability in leadership and prestige.

What kind of a specification should be drawn for an ideal leader, and how should the characteristics be weighted? A sample specification might follow this pattern:

Specification Qualities	*Factor Weight*
1) Character, intellectual honesty, dependability, courage to defend principles regardless of pressures	25%
2) Previous success in building and maintaining good-will, respect, and loyalty of subordinates	15%
3) Sense of proportion, common sense, judgment, diplomacy, personality	15%
4) Previous success in administration, and applying the principles of organization	15%
5) Success in developing and improving subordinates by imparting information and correctly interpreting company policies	15%
6) Knowledge of the details of the entire business	10%
7) Creativeness	5%
Total	100%

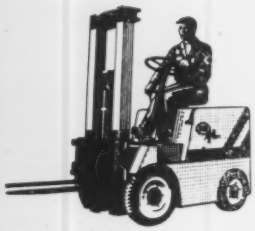
If anyone feels the urge to amend the listing of specific qualities, or make some changes in the weighting of factors or the order in which they are given, I would not object as long as No. 1 remains 1 in weight, and numbers 2 and 3 are given a prominent part in the specification.

How many companies, may I ask, actually have a specification written out and published for top positions? And again, how many companies have a specification for the man to fill the job which is weighted as indicated above?

The curricula of educational institutions give considerable attention to methods and procedures, but a skimpy minimum, and perhaps none, to the calibre of the men who are to administer the methods and procedures.

In view of the publicity given to TV quiz scandals and Senate investigations in which shady morals in many fields are being brought into the open, newspapers and magazines are currently emphasizing the need for more morality. A recent editorial in a weekly prominent magazine stated that all of these revelations are "a symptom of the declining standards of moral behavior in the United States".

Isn't the time ripe for boards of directors, executive officers, schools of business administration, trade and other associations, political party leaders, and others, to give emphasis to improving the personal character of leadership? This, after all, can be the one factor in improving the general tone of human relations in all fields, and help to utilize more fully improvements in science and technology. ■



AN INTRODUCTION TO INVENTORY MANAGEMENT

By BILLY E. GOETZ

Dr. Goetz is professor of industrial management at the Massachusetts Institute of Technology

THE ARTICLE attempts to give managers who have forgotten their school mathematics some understanding of the mathematical approach to batch process inventory control. For this purpose, we develop models to exhibit the nature of the problem of determination of reorder levels and economic lot sizes and the nature of the mathematical approach to this problem. We use the simplest of models, leaving executives confronted by these problems to recruit competent staff or consulting assistance to adapt the models to the complexities almost invariably encountered in practical application.

The Saw Tooth Model

We assume items come into inventory a batch at a time (a flow of items into inventory over a period during which issues also occur is one complication for the staff specialist), and a uniform rate of issue (seasonal and random fluctuations in usage rate we also leave to the manager's staff). In this section, we also assume a constant, known replacement interval (often called travel time) between order of items and receipt by stockroom. In the next section, we will relax this assumption in favor of an assumption of a variable, unknown travel time.

With these assumptions, a graph of inventory against time will be a regular saw tooth pattern with equally spaced vertical rises showing receipt of batches and uniformly slanting lines showing usage (Fig. 1). With everything so known and regular, there will be no need for cushion stocks, so inventory will run out altogether just as the next batch is received.

The maximum inventory is the lot size. The average inventory equals ½ the lot size. The minimum inventory equals zero.

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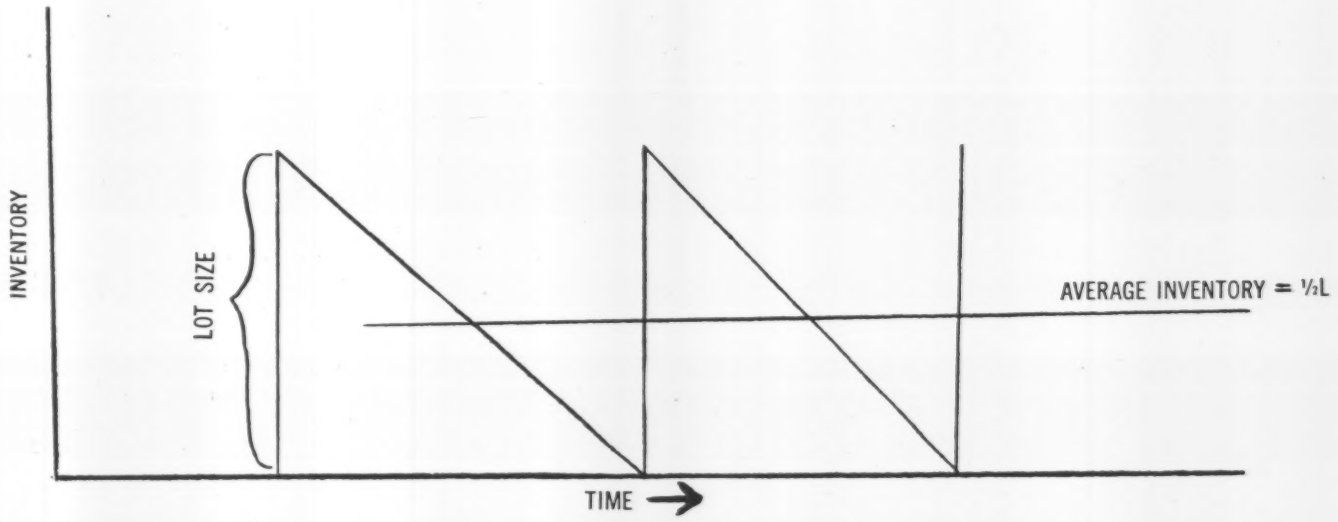

FIGURE 1

The Economic Lot Size Model

Total annual cost can be analyzed into a number of components:

A) A number of fixed costs such as real estate taxes, president's salary. These can be recognized by their complete independence of changes in number of units produced and/or number of batches in which this number of units is produced. We will designate the annual total of such fixed costs by the symbol F.

B) A number of variable costs which depend solely upon the number of units made. For example, the difference in total out-of-pocket cash cost between producing 100,000 and producing 100,001 is the *incremental* cost added to total cost by producing one more unit. These variable unit costs usually include direct materials, direct labor, and variable burden. We will leave their identification and measurement to your cost estimators. However, you should insist that they exclude allocated costs whose total does not change because one additional unit has been made. The annual total of these variable unit costs will be equal to the variable unit cost of one unit multiplied by the number of units made during the year (complications such as quantity discounts and overtime wage premiums we will leave to your staff specialists). We will designate the incremental cost due to a single added unit by V, and the number of units produced per year by Q. Total variable unit costs for a year will then be VQ.

C) A number of variable costs which depend upon the number of batches produced. For example, if 120,000 units per year are produced, they can be produced in 4 batches of 30,000 each or in 3 batches of 40,000 each. The difference in total estimated cost between these two production programs is the batch cost, which we designate by the symbol B. Batch costs usually include set-up costs, the paperwork cost of preparing an extra set of order forms and entering an extra set of figures in inventory and other records. If we designate the lot size by the symbol L, there will be Q/L batches produced per year, and annual batch costs will be $\frac{QB}{L}$.

D) A number of variable costs which depend upon the size of the inventory. If we make fewer larger batches, the average inventory L/2 will be greater and such annual carrying costs as interest, shelf-wear, obsolescence, insurance, personal property taxes, etc. will be proportionately increased. We will designate such financial charges as C, which will be a percentage of the value of the average inventory (we will leave space costs,which depend on size rather than value, to your staff specialists). We convert the average inventory (=L/2 pieces) into dollars by multiplying by variable unit costs, and then apply our carrying cost percentage (cost of carrying $1 worth of inventory for one year). This gives an annual carrying cost of $\frac{LVC}{2}$.

Now, we can put this all together into a formula for total annual costs (designated by the symbol T):

$$T = F + VQ + \frac{QB}{L} + \frac{LVC}{2}$$

Also, we can graph this equation, as in Figure 2. Figure 2a shows each component graphed separately. Figure 2b adds components successively until the upper curve shows how total costs first fall, reach a minimum, and then rise as the lot size is increased. The economic lot size is determined in figure 2a by the intersection of the batch cost $\frac{QB}{L}$ curve with the carrying cost ($\frac{1}{2}LVC$) curve. On Figure 2b the low point of the total curve ($F + VQ + \frac{1}{2}LVC + \frac{QB}{L}$) determines the economic lot size. (We will leave it to your staff specialist to show that the two are equivalent ways of doing the same thing. The intersection rule is a very special and limited case.)

The $\frac{QB}{L}$ curve intersects the $\frac{1}{2}$ LVC curve where these two cost components are equal. Therefore we can write the following formula for finding the economic lot size:

$$\frac{QB}{L} = \frac{LVC}{2} \quad \text{or} \quad L = \sqrt{\frac{2QB}{VC}}$$

If we assume the following:

Setup costs	= $6 per run	Materials cost	= $.08 per unit
Paperwork costs	= 3	Labor cost	= .06
Variable batch costs	= $9 per run	Variable burden	= .02
		Variable unit costs	= $.16 per unit

Interest	= 25%
Shelfwear	= 6
Obsolescence	= 4
Other carrying charges	= 1
Variable carrying cost	= 36%

Annual usage	= 80,000 units
Daily usage	= 320 units
Costs of stockouts	= $2 per day

Then: $$L = \sqrt{\frac{2QB}{VC}} = \sqrt{\frac{2 \times 80{,}000 \times 9}{.16 \times .36}} = 5{,}000 \text{ units per batch}$$

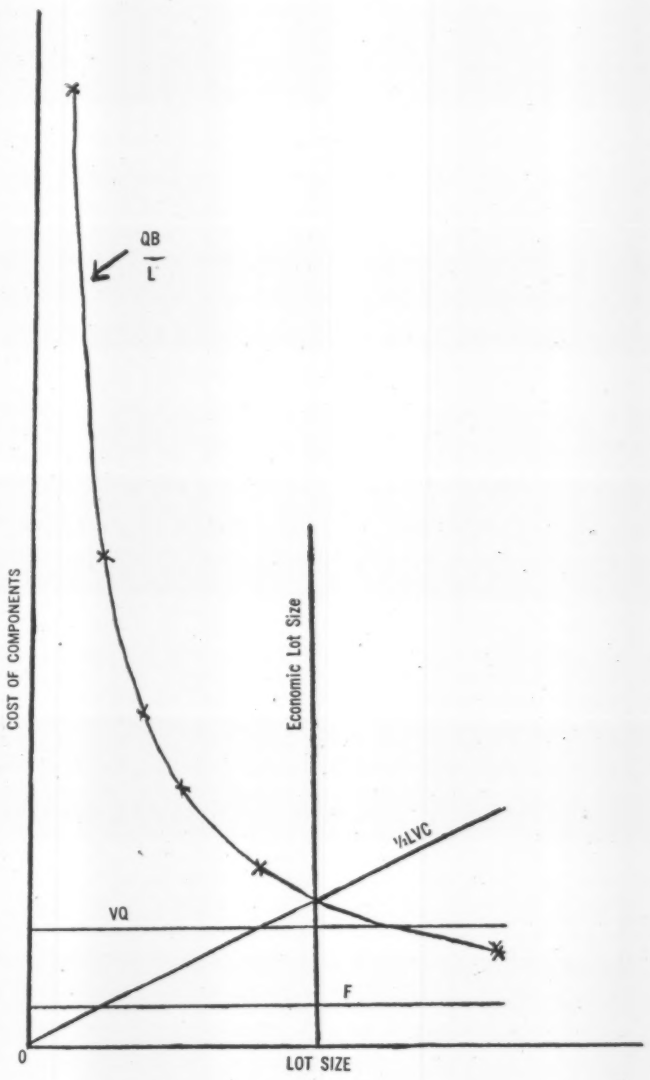

FIG. 2a

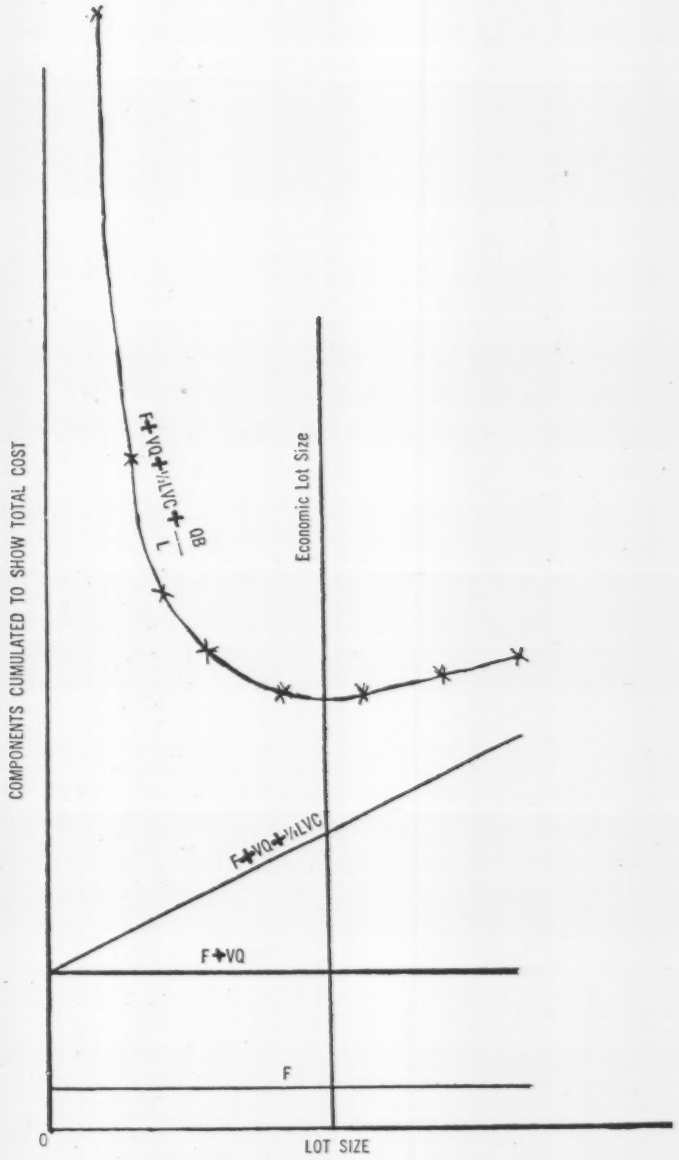

FIG. 2b

The Payoff Table Model

Seldom does the real world behave in such orderly and predictable a fashion. Usage varies seasonally and randomly (and we will continue to leave this problem to your staff specialists). Travel time from placing an order to receipt of the goods ordered normally exhibits some variation, and this we will now analyze.

Variable travel time means that whatever time we allow, orders will sometimes be received before expected and sometimes after expected. When received sooner, we have ordered sooner than we would have chosen had we had perfect fore-knowledge. The new order comes in before we have used up all that we had previously had on hand. This residue left over is an unnecessary inventory on which we incur unnecessary carrying charges—the cost of not knowing precisely how long *this* order would take. When received later than expected, we incur costs of stockout, such as lost profits when disappointed customers buy elsewhere, or the costs of shutting down our assembly line because component parts failed to arrive when expected. Naturally, we will minimize such costs by buying small quantities locally, by breaking lots and expediting partial orders. The costs of stockouts relevant to our problem are these minimized costs which we can avoid only by avoiding stockouts.

Our problem is to establish a lead time for placing orders which will minimize the annual total of the extra carrying costs plus the costs of stockouts as each is defined in the preceding paragraph.

This problem of lead time, or reorder level if you prefer, is inextricably interwoven with the problem of economic lot

NOTE: *The numerical illustration is adapted from pp. 499-510 of Goetz and Klein,* Accounting in Action: Its Meaning for Management, *Houghton & Mifflin, 1960.*

Lead Time Allowed	7	8	9	10	11
Actual Travel Time					
7	0	18.43	36.86	55.30	73.73
8	2.00	0	18.43	36.86	55.30
9	4.00	2.00	0	18.43	36.86
10	6.00	4.00	2.00	0	18.43
11	8.00	6.00	4.00	2.00	0

Figure 3

size. We undergo the possibility of stockout towards the end of each purchase or production cycle. With fewer larger lots, we take this risk less frequently and consequently the long-term total of costs of stockouts will be lower. The costs of stockouts is a true batch cost, to be included in B when we determine our economic lot size by means of our formula as in the preceding section.

However, costs of stockout are not incurred in every cycle, only in those cycles where travel time has turned out longer than expected. This brings us to the concept of mathematical expectation or expected costs. If a cost occurs in very nearly half the cycles, the expected cost per cycle is one-half the cost per stockout. E.g., if we have 20 cycles in a year and experience stockout costs of $2 in half of them, total cost of stockout for the year will be $\frac{20}{2} \times \$2 = \$20$, or an expectation of $1 per cycle. The carrying costs on the inventory remaining when a new batch is received is likewise an expected cost since it will occur in some cycles and not in others.

It is difficult to go further by means of general discussion. We will revert to the illustrative example of the preceding section, but we will need additional data. We will assume that we never receive an order within six days of placing the order, that 10% of the time it takes exactly seven days, 20% of the time exactly 8 days, 40% of the time exactly 9 days, 20% of the time exactly 10 days, and 10% of the time exactly 11 days, which accounts for 100% of the time.

Now we prepare a payoff table. We can order 7, 8, 9, 10, or 11 days before we expect to need the material. Of course, we could order allowing only 4 or 5 or 6 days lead time, but this will prove too expensive because of excessive costs of stockout. And, since it never takes longer than 11 days, allowing more time needlessly runs up our carrying costs. Our payoff table will have a column for each lead time we may allow. It will have a row for each travel time which may occur. And in each box, we will enter the extra stockout or carrying cost associated with that combination of planned lead time and actual travel time.

Suppose we consider the $4.00 in the box in the column headed 8 and row headed 10. The column heading says we allowed 8 days, the row heading that it took 10 days. Consequently we would be out of stock for 2 days. We have assumed that stockouts cost $2 per day (the cost does tend to increase with time). Since we are out of stock for 2 days, we enter $4 in this box.

Suppose we consider the $55.30 in the box in the column headed 11 and the row headed 8. Here we receive the new batch while we still have 3 days' supply on hand. Since usage was estimated at 320 units per day, this will be 960 units, each costing $.16. Thus we have had $153.60 more invested in inventory than turned out to be necessary. At a carrying cost of 36% per year, this gives an extra carrying cost of $55.296 per year, rounded off to $55.30.

Now, we reduce all of the cost figures in the table to their mathematical expectations by multiplying each by the probability that it will occur, that is, by the probability that the travel time indicated by the row heading will occur. This is done in Figure 4.

The .80 in the box in the column assuming 8 days allowed lead time and in the row assuming 10 days actual travel time is the $4 in the corresponding box in Figure 3, multiplied by the .2 or 20% chance of getting an order 10 days after placing it. Notice that this, and all expected values in boxes below the zeros, and the partial totals at the bottom of Figure 4 are all expected costs *per cycle*. To find the expected costs per year, we shall have to multiply each by the number of cycles (batches) per year, that is by Q/L.

The $7.372 in the box in the column headed 10 and row headed 8 is the $36.86 in the corresponding box in Figure 3 multiplied by the probability of receiving our order 8 days after placing it. Notice that this expected carrying cost, and all the expected costs in boxes above the zeros, and the partial totals at the top of Figure 4 are all expected costs *per year*.

Lead Time Allowed		7	8	9	10	11
Total Expected Carrying Cost			1.843	7.373	20.275	36.864
Actual Travel Time	Probability					
7	.1	0	1.843	3.686	5.530	7.373
8	.2	.40	0	3.686	7.373	11.060
9	.4	1.60	.80	0	7.373	14.746
10	.2	1.20	.80	.40	0	3.686
11	.1	.80	.60	.40	.20	0
Total Expected Stockout Cost		4.00	2.20	.80	.20	0

Figure 4

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The Amended Lot Size Model

Now, we can amend our lot size formula by including the expected costs of stockout in batch costs. We now ask a series of questions:

1. If we allow 7 days lead time, what will be the economic lot size?
2. If we allow 8 days lead time, what will be the economic lot size?
3. If we allow 9 days lead time, what will be the economic lot size?
4. If we allow 10 days lead time, what will be the economic lot size?
5. If we allow 11 days lead time, what will be the economic lot size?

And we answer each by applying our economic lot size formula:

$$L = \sqrt{\frac{2QB}{VC}}$$

1. $L_7 = \sqrt{\frac{2 \times 80{,}000(9 + 4)}{.16 \times .36}} = \frac{400}{.24}\sqrt{13} = 1667\sqrt{13} = 6{,}000$ units
2. $L_8 = \sqrt{\frac{160{,}000(9 + 2.2)}{.0576}} = 1667\sqrt{11.2} = 5{,}583$ units
3. $L_9 = 1667\sqrt{9 + .8} = 5{,}217$ units
4. $L_{10} = 1667\sqrt{9.2} = 5{,}067$ units
5. $L_{11} = 1667\sqrt{9} = 5{,}000$ units

Which of these five combinations is best?

The Amended Total Cost Model

We return to the total cost model shown on page 22. However, we can drop F and VQ since these are alike for all combinations of reorder levels and lot sizes. And we must add a term for the expected costs of carrying extra inventory because we estimated travel times incorrectly. Using the symbol $\hat{S}$ for the expected costs of stockout per batch, and $\hat{C}$ for the expected extra carrying cost per year, our amended total cost formula is:

$$T = \frac{Q(B + \hat{S})}{L} + \frac{LCV}{2} + \hat{C}$$

We apply this formula to each of the five combinations worked out in the preceding section.

1. $T_7 = \frac{80{,}000(9 + 4)}{6{,}000} + \frac{6{,}000(.16)\ (.36)}{2} + 0$
   $= 176.67 + 172.80 = \$349.47$ per year
2. $T_8 = \frac{80{,}000(9 + 2.2)}{5{,}583} + \frac{5{,}583(.16)\ (.36)}{2} + 1.84$
   $= 156.90 + 160.79 + 1.84 = \$319.53$ per year
3. $T_9 = \frac{80{,}000(9 + .8)}{5{,}217} + \frac{5{,}217(.16)\ (.36)}{2} + 7.372$
   $= 150.30 + 150.25 + 7.37 = \$307.92$ yer year
4. $T_{10} = \frac{80{,}000(9 + .2)}{5{,}067} + \frac{5{,}067(.16)\ (.36)}{2} + 20.28$
   $= 145.25 + 145.93 + 20.28 = \$311.46$ per year
5. $T_{11} = \frac{80{,}000(9)}{5{,}000} + \frac{5{,}000(.16)\ (.36)}{2} + 36.86$
   $= \$144.00 + \$144.00 + 36.86 = \$324.86$ per year

Continued on next page

Thus we see that the combination of a reorder level of 9 days' supply = 2880 units and an economic lot size of 5217 units gives the lowest total annual cost. Further, that out of every 100 cycles we can "expect" a one-day stockout twice and a two-day stockout once. Similarly, on two occasions the new order will come in twice while we still have one day's supply on hand, and once while we still have two days' supply on hand (see column headed 9 on Figure 4). We can also see the rate at which costs increase as we depart from the optimum solution; e.g., ordering 5067 whenever our inventory falls to 10 days' supply costs 311.46 — 307.92 = $3.54 per year more than the best we can do.

The Cost Contour Model

We may want to know the extra costs of departing from optimum via other combinations of batch size and reorder level. The cost contour model will answer all such questions. In any event, the cost contour model gives a different and more comprehensive picture of the nature of the problem and of its solution.

We could graph the dependence of total annual cost on reorder level and lot size, but it will take three dimensions. If we put total annual cost on the vertical axis, and reorder level and lot size on two perpendicular horizontal axes, the relationship plots as a bowl-shaped surface, and our problem is to find the low point of the bowl. This is hard to visualize, to draw, or to plot. Hence we have recourse to use of a contour map of the bowl.[1]

We have already calculated five points of such a cost contour map. Figure 5 shows these five points as small circles. Lot size is scaled on the long axis, and reorder level on the short axis. Of the five points we have already computed, the combination of reorder level of 7 days with lot size of 6000 has the highest cost. To get some idea of the shape of the total cost bowl, we will calculate some other combinations of lot size and reorder level which will yield this same cost of $346.13 per year. As we would expect, these points indicate the general shape of a closed curve encircling the other four points already computed. These additional points on the $346.13 contour are calculated below and shown on Figure 5 by small crosses.

We return to our amended total cost model.

$$T = \frac{Q(B + \hat{S})}{L} + \frac{LCV}{2} + \hat{C}$$

We have chosen T = $349.47 as the contour level to plot. We will assume successive reorder levels of 8, 9, 10, and 11 days supply and calculate the lot size associated with each that will produce a total annual cost of $349.47.

From Figure 4, a reorder level of 8 days supply gives an expected carrying cost = $\hat{C}$ of $1.84 per year and an expected cost of stockouts = $\hat{S}$ of $2.20 per cycle. Note that in our total cost model $\hat{S}$ is multiplied by the number of batches per year = Q/L. Then for T = $349.47 and reorder level equals 8 days supply, we have:

$$T = 349.47 = \frac{80{,}000(9 + 2.20)}{L} + \frac{L(.16)\,(.36)}{2} + 1.84$$

$$\text{or } .0288L^2 - 347.63L + 896{,}000 = 0 \text{ (See footnote 2)}$$

$$\text{then } L = \frac{347.63 \pm \sqrt{(347.63)^2 - 4(.0288)\,(896{,}000)}}{2(.0288)}$$

$$= \frac{347.63 \pm \sqrt{120{,}847 - 103{,}219}}{.0576} = \frac{347.63 \pm 133}{.0576}$$

$$L = \frac{347.63 + 133}{.0576} = 8{,}344 \qquad L = \frac{347.63 - 133}{.0576} = 3{,}726$$

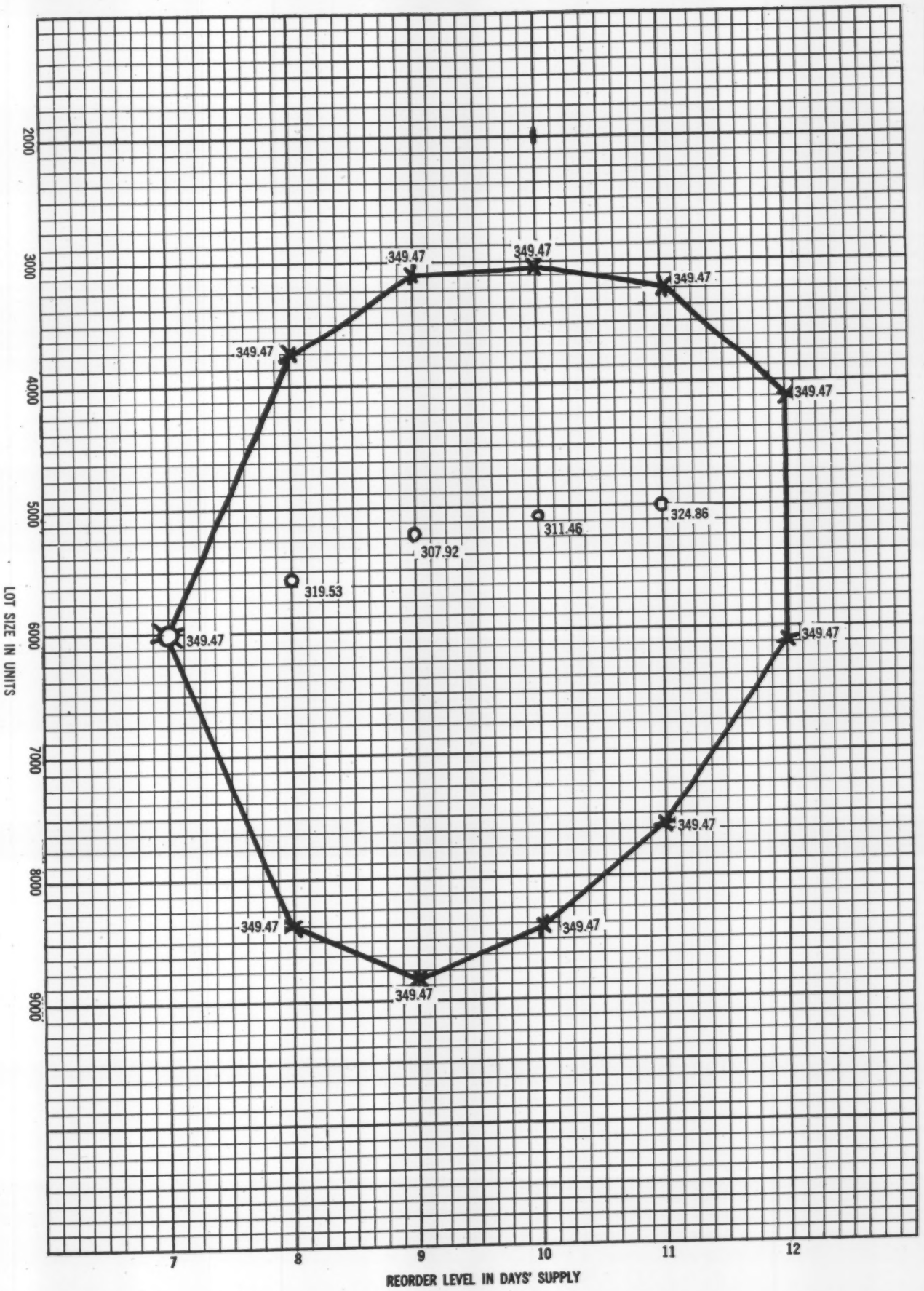
Continued on page 28

1 Assume we have a dry bowl, say where Lake Mead now is. We erect a very tall pole at the very lowest point on the proposed lake bed, and mark it off in 10 foot intervals. Then we build Hoover Dam and the lake begins to fill. Every time the water surface reaches a 10 foot mark on our very tall pole, we take an aerial photograph of the shore line. When the lake has filled, we carefully superimpose our photographs, marking each waterline with the associated level marked on our tall pole. The result is a contour map of the lake bottom.

2 You may remember from your high school algebra: The general quadratic is: $ax^2 + bx + c = 0$, and its general solution for x is:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If you have doubts or questions, discuss this with your specialist associate.


2000
3000
4000
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7000
8000
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LOT SIZE IN UNITS
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349.47
349.47
349.47
349.47
349.47
307.92
311.46
324.86
319.53
7
8
9
10
11
12
REORDER LEVEL IN DAYS' SUPPLY

FIG. 5

We repeat for a reorder level of 9 days supply with T still equal to \$346.13. From Figure 4, column headed 9, $\hat{S} = .80$ and $\hat{C} = 7.37$:

$$T = \$349.47 = \frac{80{,}000(9 + .8)}{L} + .0288L + 7.37$$

or $.0288L^2 - 342.10L + 784{,}000 = 0$ and

$$L = \frac{342.10 \pm \sqrt{(342.10)^2 - 4(.0288)\,(784{,}000)}}{.0576}$$

$L = (342.10 + 163)/.0576 = 8{,}769$

$L = (342.10 - 163)/.0576 = 3{,}109$

From Figure 4, a reorder level of 10 days supply carries an expected cost of stockouts of \$.20 per cycle and an expected carrying cost = $\hat{C}$ of \$20.27 per year. Consequently.

$$T = 349.47 = \frac{80{,}000(9 + .2)}{L} + .0288L + 20.27$$

or $.0288L^2 - 329.20L + 736{,}000 = 0$

$$L = \frac{329.20 \pm \sqrt{(329.20)^2 - .1152(736{,}000)}}{.0576} = \frac{329.20 \pm (154)}{.0576}$$

$L = 483.20/.0576 = 8{,}388$ $\qquad$ $L = 175.20/.0576 = 3{,}042$

Finally, for a reorder level of 11 days supply, we have $\hat{S} = 0$ and $\hat{C} = 36.86$:

$$T = 349.47 = \frac{80{,}000 \times 9}{L} + .0288L + 36.86$$

$.0288L^2 - 313.61L + 720{,}000 = 0$

$$L = \frac{313.61 \pm \sqrt{(313.61)^2 - .1152(720{,}000)}}{.0576} = \frac{313.61 \pm 124}{.0576}$$

$L = 189.61/.0576 = 3{,}292$ $\qquad$ $L = 437.61/.0576 = 7{,}597$

While we know reordering at 12 days supply makes no sense, we can see if such behavior can couple with a lot size to give a total annual cost of \$346.13:

$$T = 349.47 = \frac{80{,}000(9)}{L} + .0288L + 55.70$$

$.0288L^2 - 293.77L + 720{,}000 = 0$

$$L = \frac{293.77 \pm \sqrt{(293.77)^2 - .1152(720{,}000)}}{.0576} = 293.77 \pm \sqrt{86{,}301 - 82{,}944}$$

$L = (293.77 + 58)/.0576 = 6{,}107$ $\qquad$ $L = 235.77/.0576 = 4{,}093$

To help the eye follow the \$349.47 cost contour, I have connected the points found by straight lines.

Intermediate points on these lines have no meaning, since under the assumptions we have been making, reorder levels are in terms of days' supply — fractions of days being without physical meaning (e.g., delivery service only once a day).

Conclusion

Reorder level and lot size are inextricably interwoven. Both must be calculated as parts of one problem. This is neatly accomplished by feeding partial totals from a payoff table into the economic lot size formula.

While we would seldom be interested in finding the whole total cost surface, since we are interested only in its lowest point, calculating points on one contour line plus the points found in calculating the minimum total cost point gives us a good picture of the nature of the problem and of the proper approach to its solution.

We can leave special modifications of the models, the determination of the components—Q, B, $\hat{S}$, V, C $\hat{C}$—and the arithmetic to our staff specialists now that we understand what they are about. We are in a position to determine the competence of our specialist, to discuss with him what we want him to do, and to understand his report when he submits it. ∎

Retiro Para Altos Ejecutivos: Report From Mexico

Monterrey Workshop Features Planned Programs, Open Minds

S.A.M. National President Dause L. Bibby and Lester M. Zerfoss, S.A.M. Vice President for Seminars and Director—Industrial Relations and Management Services at American Enka Corp., were recently invited to participate in a workshop for executives in Northern Mexico, sponsored by the Centro de Productividad de Monterrey.

Since urgent company business required Mr. Bibby's presence in Europe at that time, Walter Mitchell Jr., Executive Director of S.A.M., joined Mr. Zerfoss to complete S.A.M.'s participation in this international venture of interchange of management ideas.

Following is Mr. Mitchell's report:

Retiro Para Altos Ejecutivos

The Spanish phrase for a management development seminar — "Retreat for High Executives"—somehow has a fascinating and rarefied atmosphere that we do not achieve in our descriptive titles for such workshops. Members of S.A.M., attending Chapter Workshops and Management Development Programs sponsored by S.A.M. and other organizations, may have wondered what goes on at similar programs in other countries.

At the workshop sponsored by the *Centro de Productividad*, which ties in with the International Cooperation Administration Program jointly sponsored by the Mexican Government and the U. S. State Department, the subjects covered—usually a whole day for thorough discussion—included the following:

Executive Development in Other Countries
Group Dynamics
The Manager's Tasks
Human Factors in Management
Development of the Capacities of the Individual
Decision Making and Delegation of Decision
Future of the Mexican Economy
Legal and Financial Problems of Enterprises
Long Range Planning

Well-Conducted, Quiet

The sessions were held in a spot sufficiently quiet and cloistered to satisfy any devotee of the monastic theory of learning. Rincon de la Montera is a resort hotel in a small desert oasis at 5000 feet elevation, 120 miles west of Monterrey. On the same days when the temperature was 110° in Monterrey it never went above 80 at the oasis, with brilliant sun and a gentle breeze, followed by the usual desert sequence of quite cold nights. With no radio, television, or even telephone, the executives in the group had no choice but to discuss, study, and occasionally take a swim.

The program was planned by Senor Reyes Salcido, Director of the Productivity Center and Prof. J. William Caldwell, of Pennsylvania State College, who has been on a six months leave of absence to assist in the development of programs in Mexico. He was assisted by Prof. Maurice Dance of San Fernando State College in California.

General conclusion of your observer: A well-planned and conducted program, with an especially interesting procedure for daily evaluation of the results. The participants were a group of gentlemen of the finest type, whose traditions draw from a culture older than that of the United States, yet whose ideas of management are modern and whose minds are open to new ideas and improvements from anywhere in the world — a group whose acquaintance any U. S. citizen can be proud to make. Your Executive Director learned a lot and recommends the experience to anyone who may have the opportunity.

Proceedings Now Available

COPIES of the Proceedings of the 15th Annual S.A.M.-A.S.M.E. Management Engineering Conference have been sent to full Conference registrants, the S.A.M. National Office has announced.

The Conference, held April 7-8 in New York, included sessions on Cost Reduction, Work Sampling, New Equipment Applications, Selling Industrial Engineering Ideas, Production and Inventory Control, Clerical Cost Reduction, Indirect Labor, Time Study and Predetermined Standards. In addition to containing transcripts of the Conference addresses, the Proceedings include reproductions of visual aids used by speakers.

Additional sets of the Proceedings, at $3.50 each for S.A.M. members and $5.00 for non-members, are now available through the S.A.M. National Office, 74 Fifth Ave., New York 11.

Commerce Secretary Mueller Names Al Seares To New Post: U. S. Foreign Trade Consultant

AL N. SEARES, S.A.M. Vice President — Marketing, was recently named Special Trade Consultant in the new National Export Expansion Program of the U. S. Bureau of Foreign Commerce. The appointment was made by Secretary of Commerce Frederick H. Mueller.

Al N. Seares

Seares, a former president of National Sales Executives—International, and more recently president of Alderson Associates, Inc., will join with other businessmen throughout the U. S. to create greater interest in export sales abroad.

Will Explore Trade Possibilities

According to a Department of Commerce spokesman, the National Export Expansion Program is designed to explore the various facets in the business community which can materially add to U. S. exports in order to reverse the recent trend of an unfavorable balance of trade, and to stimulate the export trade community toward giving fuller attention to: 1) Free trade possibilities and problems in face of the newly emerging regional trade communities; and 2) Increased world trade competitive conditions with respect to pricing, supply, accelerated world-wide industrialization, bloc disturbances of free trade patterns, and related factors.

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